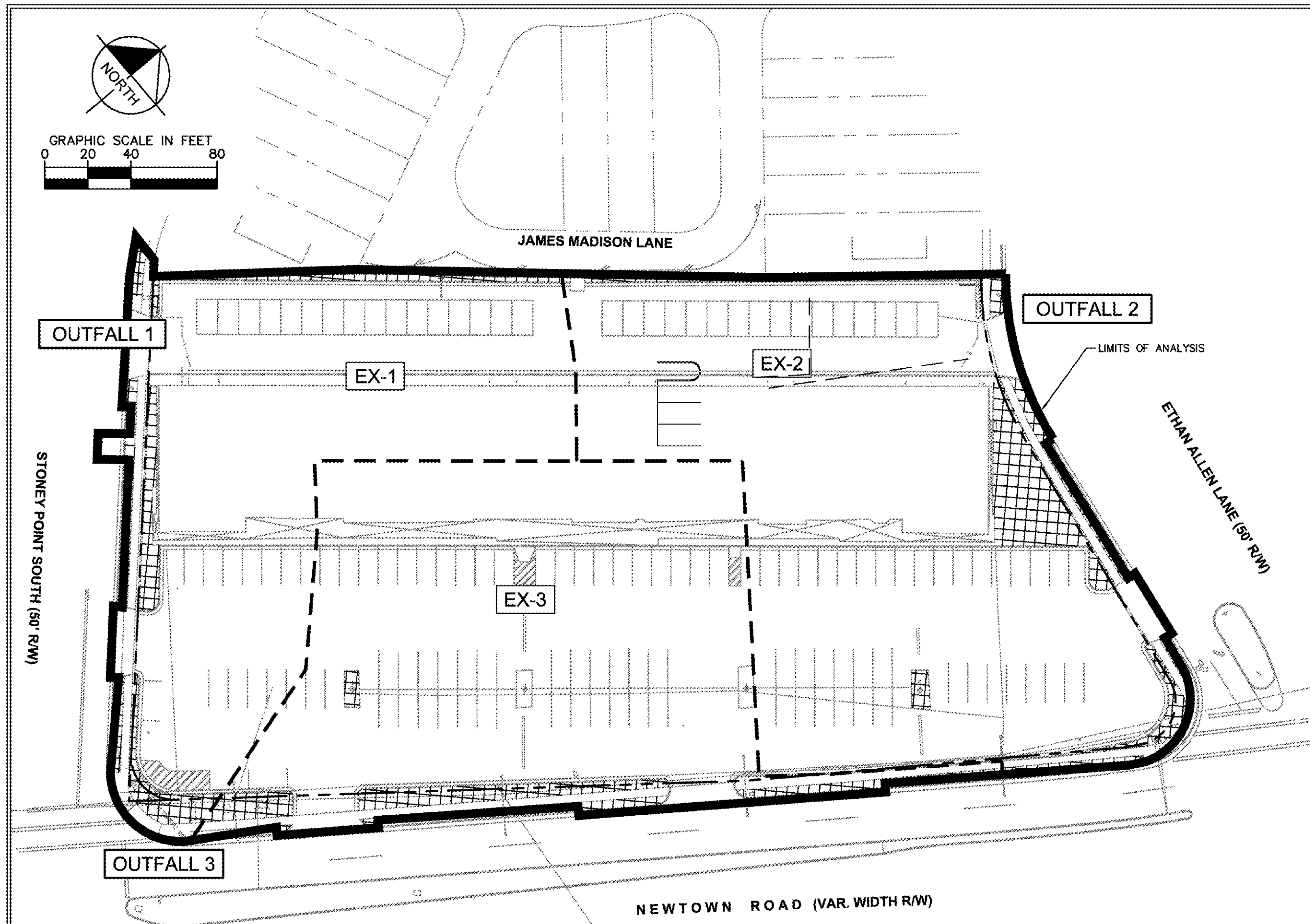
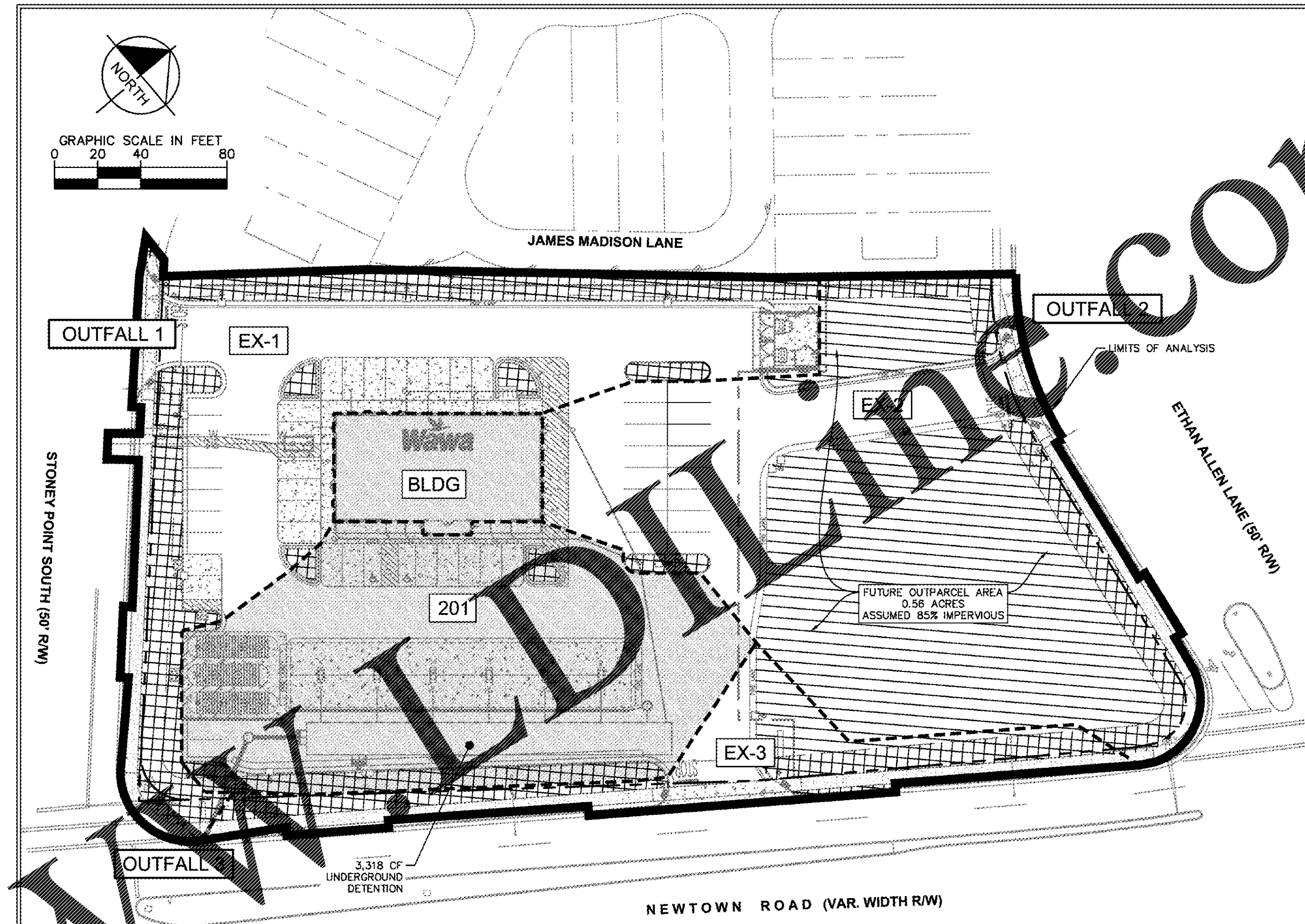
PRE-DEVELOPMENT



POST-DEVELOPMENT



OUTFALL 1 ENERGY BALANCE

Pre-Development

			Storm Event	Runoff Volume V	Peak Flow q (cfs)
Runoff Curve Number (CN)	95				
Drainage Area	0.74	acres			
Impervious Area	0.67	acres	1 -year	6,021	2.76
Managed Turf	0.07	acres	10 -year		5.42
Forest/Open Space	0.00	acres			
Time of Concentration (Tc)	5.0	min			

Post-Development (Prior to Routing)

				Storm Event	Runoff Volume V	Peak Flow q (cfs)
Runoff Curve Number (CN)	1 yr	87				
Runoff Curve Number (CN)	10 yr	87				
Drainage Area		0.69	acres	1 -year	3,961	1.95
Impervious Area		0.49	acres	10 -year		4.49
Managed Turf		0.20	acres			
Forest/Open Space		0.00	acres			
Time of Concentration (Tc)		5.0	min			

Channel Protection Compliance

Energy Balance Equation, 1-year Storm
Improvement Factor 0.8

Q_post	<	I.F. x Q_pre x RV_pre/RV_post	
	<	0.8	x 2.76 x 6021 / 3961
1.95	<	3.36	
PASS			

Flood Protection Compliance

10-year storm

Q_post	<	Q_pre
4.49	<	5.42
PASS		

OUTFALL 2 ENERGY BALANCE

Pre-Development

			Storm Event	Runoff Volume V (cu ft)	Peak Flow q (cfs)
Runoff Curve Number (CN)	95				
Drainage Area	1.01	acres			
Impervious Area	0.93	acres			
Managed Turf	0.08	acres	1 -year	8,218	[illegible]
Forest/Open Space	C	acres	10 -year		7.40
Time of Concentration (Tc)	5.0	min			

Post-Development (Prior to Routing)

				Storm Event	Runoff Volume V (cu ft)	Peak Flow q (cfs)
Runoff Curve Number (CN)	1 yr	92				
Runoff Curve Number (CN)	10 yr	90				
Drainage Area		0.93	acres	1 -year	6,66[illegible]	3.[illegible]7
Impervious Area		0.77	acres	10 -year		[illegible].58
Managed Turf		0.16	acres			
Forest/Open Space		0.00	acres			
Time of Concentration (Tc)		5.0	min			

Channel Protection Compliance

Energy Balance Equation, 1-year Storm
Improvement Factor 0.[illegible]

Q_post	<	I.F. x Q_pre x RV_pre/RV_post	
	<	0.[illegible]	x [illegible].77 x 821[illegible] / [illegible]661
3.1[illegible]	<	3.8[illegible]	
PASS			

Flood Protection Compliance

10-year storm

Q_post	<	Q_pre
6.58	<	7.40
PASS		

OUTFALL 3 ENERGY BALANCE

Pre-Development

			Storm Event	Runoff Volume V (cu ft)	Peak Flow q (cfs)
Runoff Curve Number (CN)	96				
Drainage Area	0.83	acres			
Impervious Area	0.79	acres			
Managed Turf	0.04	acres	1 -year	7,042	3.17
Forest/Open Space	0.00	acres	10 -year		6.13
Time of Concentration (Tc)	5.0	min			

Post-Development (Prior to Routing)

				Storm Event	Runoff Volume V (cu ft)	Peak Flow q (cfs)
Runoff Curve Number (CN)	1 yr	93				
Runoff Curve Number (CN)	10 yr	93				
Drainage Area		0.96	acres	1 -year	7,177	3.38
Impervious Area		0.82	acres	10 -year		6.88
Managed Turf		0.14	acres			
Forest/Open Space		0.00	acres			
Time of Concentration (Tc)		5.0	min			

Channel Protection Compliance

Energy Balance Equation, 1-year Storm
Improvement Factor 0.8

Q_post	<	I.F. x Q_pre x RV_pre/RV_post	
	<	0.8	x 3.17 x 7042 / 7177
3.38	<	2.49	
		FAIL	**DETENTION REQ'D

Flood Protection Compliance

10-year storm

Q_post	<	Q_pre	
6.88	<	6.13	
		FAIL	**DETENTION REQ'D

Post-Development Summary (Routed flows)

Storm Event	Peak Flow q (cfs)			
1 -year	2.45	(< Required	2.49	cfs)
10 -year	5.83	(< Required	*6.13*	cfs)

STORMWATER QUANTITY NARRATIVE

TO ADDRESS STORMWATER QUANTITY REQUIREMENTS FOR THE PROPOSED SITE, THE ENERGY BALANCE METHOD WAS CHOSEN. THE LIMITS OF ANALYSIS USED FOR THE ENERGY BALANCE CALCULATIONS INCLUDES THE ENTIRE LIMITS OF DISTURBANCE (2.58 ACRES).

THERE ARE THREE POINTS OF OUTFALL ON THE SITE:

- OUTFALL 1: THE WEST SIDE OF THE SITE SHEET FLOWS TO THE NORTHWEST AND ULTIMATELY DRAINS TO A CURB INLET WITHIN STONEY POINT SOUTH.
- OUTFALL 2: THE NORTH SIDE OF THE SITE SHEET FLOWS OFF SITE AND FLOWS NORTH ALONG ETHAN ALLEN LANE.
- OUTFALL 3: THE SOUTHEAST SIDE OF THE SITE DRAINS TO AN EXISTING INLET ALONG NEWTOWN ROAD.

THE ENERGY BALANCE IS MET FOR OUTFALLS 1 AND 2 BASED ON A REDUCTION IN AREA. IN ORDER TO MEET THE ENERGY BALANCE REQUIREMENTS FOR THE 1-YEAR STORM AT OUTFALL 3, UNDERGROUND DETENTION IS PROPOSED ON THE SOUTHEAST SIDE OF THE WAWA CANOPY. A STORMTANK DETENTION SYSTEM WITH A CONTROL STRUCTURE IS PROPOSED TO REDUCE THE FLOW TO THE REQUIRED 1-YEAR FLOW RATE. SIMILARLY, DETENTION OF THE 10-YEAR STORM IS ALSO REQUIRED, SO THE CONTROL STRUCTURE WILL LOWER THE POST-DEVELOPMENT 10-YEAR FLOW RATE BELOW THE 10-YEAR PRE-DEVELOPMENT RATE.

A HYDRAFLOW MODEL WAS USED TO DESIGN THE DETENTION SYSTEM. THE MODEL INCLUDES 2 DRAINAGE AREAS TO MEET THE REQUIREMENTS OF THE ENERGY BALANCE: THE AREA ON-SITE WHICH DRAINS TO THE DETENTION SYSTEM (POST TO DETENTION) AND THE AREA THAT CANNOT BE CONVEYED TO THE UNDERGROUND SYSTEM (BYPASS). THESE AREAS WERE COMBINED INTO ONE HYDROGRAPH (ENERGY BALANCE) TO SHOW THAT THE 1-YEAR AND 10-YEAR POST DEVELOPMENT FLOW REQUIREMENTS ARE MET AT THE POINT OF OUTFALL.

CHANNEL PROTECTION: THE ENERGY BALANCE HAS BEEN USED AT THE OUTFALL TO MANAGE RUNOFF.

FLOOD PROTECTION: POST-DEVELOPMENT 10-YEAR FLOWS HAVE BEEN KEPT BELOW THE PRE-DEVELOPMENT 10-YEAR FLOW RATE.

1-YEAR STORM ROUTING SUMMARY

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	9.814	2	716	21,804	-----	-----	-----	PRE-DEV TOT
2	SCS Runoff	2.759	2	716	6,021	-----	-----	-----	PRE-DEV OUT1
3	SCS Runoff	3.766	2	716	8,218	-----	-----	-----	PRE-DEV OUT2
4	SCS Runoff	3.170	2	716	7,042	-----	-----	-----	PRE-DEV OUT3
5	SCS Runoff	1.949	2	716	3,961	-----	-----	-----	POST-DEV OUT1
6	SCS Runoff	3.173	2	716	6,661	-----	-----	-----	POST-DEV OUT2
7	SCS Runoff	3.382	2	716	7,177	-----	-----	-----	POST-DEV OUT3
8	SCS Runoff	0.704	2	716	1,445	-----	-----	-----	BYPASS
9	SCS Runoff	2.653	2	716	6,176	-----	-----	-----	POST TO DETENTION
10	Reservoir	1.868	2	720	4,268	9	13.29	2,654	DETENTION
11	Combine	2.453	2	718	5,713	8, 10	-----	-----	ENERGY BALANCE

10-YEAR STORM ROUTING SUMMARY

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	18.99	2	716	43,990	-----	-----	-----	PRE-DEV TOT
2	SCS Runoff	5.420	2	716	12,378	-----	-----	-----	PRE-DEV OUT1
3	SCS Runoff	7.398	2	716	16,894	-----	-----	-----	PRE-DEV OUT2
4	SCS Runoff	6.133	2	716	14,207	-----	-----	-----	PRE-DEV OUT3
5	SCS Runoff	4.491	2	716	9,487	-----	-----	-----	POST-DEV OUT1
6	SCS Runoff	6.577	2	716	14,491	-----	-----	-----	POST-DEV OUT2
7	SCS Runoff	6.878	2	716	15,321	-----	-----	-----	POST-DEV OUT3
8	SCS Runoff	1.553	2	716	3,328	-----	-----	-----	BYPASS
9	SCS Runoff	5.013	2	716	11,999	-----	-----	-----	POST TO DETENTION
10	Reservoir	4.329	2	718	10,091	9	13.77	3,200	DETENTION
11	Combine	5.827	2	718	13,420	8, 10	-----	-----	ENERGY BALANCE

DRAINAGE AREA SUMMARY

DRAINAGE AREA LABEL	INLET	TOTAL AREA (AC.)	IMPERVIOUS AREA (AC.)	MANAGED TURF AREA (AC.)	FOREST/ OPEN SPACE AREA (AC.)	C	CN	CA	TIME OF CONC. Tc (min)
EX-1	EX-1	0.74	0.67	0.07	0.00	0.85	96	0.625	5.0
EX-2	EX-2	1.01	0.93	0.08	0.00	0.85	96	0.861	5.0
EX-3	EX-3	0.83	0.79	0.04	0.00	0.87	97	0.723	5.0
Pre total		2.58	2.39	0.19	0.00	0.86	96		5.0
EX-1	EX-1	0.69	0.49	0.20	0.00	0.73	91	0.501	5.0
EX-2	EX-2	0.93	0.77	0.16	0.00	0.80	94	0.741	5.0
EX-3	EX-3	0.23	0.14	0.09	0.00	0.67	89	0.153	5.0
201	201	0.62	0.57	0.05	0.00	0.85	96	0.524	5.0
BLDG	BLDG	0.11	0.11	0.00	0.00	0.90	98	0.099	5.0
Post Total		2.58	2.08	0.50	0.00	0.78	93		5.0

LEGEND

MANAGED TURF	DRAINAGE STRUCTURE CALLOUT (XXX)
IMPERVIOUS COVER	DRAINAGE AREA LABEL (EX-1)
DETENTION DRAINAGE AREA (0.67 ACRES)	DRAINAGE BOUNDARY
FUTURE OUTPARCEL AREA (ASSUMED 85% IMPERVIOUS)	LIMITS OF ANALYSIS (2.58 ACRES)

REVISIONS | No. | DATE | BY

Kimley»Horn

1700 WILLOW LAWN DR, SUITE 200, RICHMOND, VA 23230
PHONE: 804-673-3882
WWW.KIMLEY-HORN.COM

COMMONWEALTH OF VIRGINIA
J. RANDALL ROYAL
Lic. No. 14950
8/24/18
PROFESSIONAL ENGINEER

KHA PROJECT	116607003
DATE	08/24/2018
SCALE	AS SHOWN
DESIGNED BY	LEY
DRAWN BY	LEY
CHECKED BY	JY

WATER QUANTITY SHEET

WAWA AT NEWTOWN AND STONEY POINT

PREPARED FOR
WAWA

CITY OF NORFOLK VIRGINIA

SHEET NUMBER
CG-201